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ABSTRACT

A theoretical framework for incorporating item response theory into the measurement of attitude and other personality processes is presented. The person by item model is introduced by considering the conceptual usefulness of such a model in understanding item responding, outlining the form of the model, briefly discussing methods for examining the model, and suggesting how educators and test constructors may use this general model to gain more detailed information about individual's responding to ability measures in light of known item characteristics. To evaluate the model, responses from 971 high school students were obtained for the 16-item Understanding subscale from the Personality Research Form (Form E). Both the item side and the person side parameters were estimated separately. Item parameters were obtained using Muthen's generalized least squares solution for ordered categorical data, whereas person parameters were estimated using the basic construct structure scaling algorithm developed by D. N. Jackson and E. Helmes (1979). Using a two-step iterative procedure, both components of the model are employed to estimate the interaction aspect of the model. In addition to the initial development and calibration of the model, other studies are under way to investigate the model's utility in actual test-taking situations. (TJH)

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# THE CONTRIBUTIONS OF PERSON PROCESSES TO MODELS OF ITEM RESPONDING

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The Contribution of Person Processes to Models of Item Responding[1]

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Over the past decade, item response theory (IRT) has been proven to be an important methodological tool for problems in educational measurement (e.g., Lord, 1980; Hambleton & Swaminathan, 1985). More recent applications of IRT have extended its scope from the abilities domain to assessment of other constructs such as attitudes and personality (e.g., Reiser, 1981; Schaeffer, 1988; Thissen, Steinberg, & Gerrard, 1986).

IRT models in educational and psychological measurement traditionally have concentrated on item properties and person abilities or attributes, but not on consistent aspects of persons other than those assumed by the latent ability/attribute. In IRT, emphasis is on the conditional probability of providing a particular response to an item and some underlying ability/attribute being assessed by that item. This emphasis may be understood in terms of the practical concerns involved in testing large examinee populations under standardized conditions. However, the notion that stable person characteristics also may impact responding within an ability/attribute domain has been largely ignored. This has been true, despite the call by numerous researchers to investigate and incorporate individual difference variables, as well as item characteristics, when assessing of educational outcomes (e.g., Messick, 1984; Traub, 1983).

Work in the personality assessment literature has implicated models of person (but not item) characteristics that describe the way in which a given item may be interpreted, evaluated, and subsequently responded to (cf., Jackson, 1986). In this domain, interest has been in understanding how individuals differ in their consistent responding with respect to an underlying dimension. These discussions of person parameters, by virtue of arising from the response style literature of the 1960's (and not the ability assessment literature), have been relatively removed from the current terminology and procedures of IRT.

*Incorporating Person Processes: Theoretical Framework*

A broader, more comprehensive model of item responding could be formulated which would account for a particular individual's response to an item with certain item characteristics. Such a model would employ not just item parameter information (e.g., in a two-parameter (2P) logistic case, the threshold and discrimination of an item), but also "person" parameter information (e.g., the threshold and discrimination across a *set* of items for a given individual).

Using parameter information from an individual's person characteristic curve (PCC) across a set of construct-related items, as well as parameter information from an item's characteristic curve (ICC) assessing that same construct, it is then possible to assess the contribution of the item, the person, and/or the person by item interaction to one's estimated ability/attribute level. Thus, instead of using one source of information to estimate an individual's level of a latent variable (obtained, for example, from the ICC), additional information would be available to predict responding (the PCC and/or the interactions between various ICC parameters and PCC parameters).

In certain respects, the proposed model can be viewed as a theoretical integration of research examining different sources of variability (cf., Cattell, 1966). The traditional IRT component of the model focuses on interitem characteristics (i.e., what properties distinguish items across persons?). The person component of the model, on the other hand, deals with interindividual characteristics (i.e., what properties distinguish individuals responding to a particular unidimensional set of items?). Clearly, a comprehensive model would need to consider both interitem and interindividual variability, as well as "the interaction" between person and item

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characteristics.

Formally, the model can be defined as follows:

Let $\Theta_i$ = person ability obtained from the ith item (via IRT methods);
$\Theta_p$ = person ability obtained from the pth person (via componential-type methods outlined for example, by Jackson (1986) and Jackson and Helmes (1979));
$\Phi_i = [a_i, b_i]$ where $a_i$ is an item discrimination parameter and b is an item threshold parameter;
$\pi_p = [a_p, b_p]$ where $a_p$ is a person discrimination parameter (e.g., the relevance or "salience" of the underlying construct for an individual, in general; cf., Rogers, 1971, 1974) and $b_p$ is a person threshold parameter (e.g., the extent to which an individual would be likely to endorse items related to the underlying dimension).
$P_{ip}(j)$ = the probability of giving the jth response on item i for person p.

The usual IRT 2P model expresses $P_{ip}(j)$ as:

$$P_{ip}(j) = f(\Theta_i, \Phi_i) \tag{1}$$

where $f$ is a monotone increasing function (such as the normal ogive or the logistic), and information is essentially collapsed over persons (i.e., the absence of parameters running over p).

A 2P person responding theory (PRT) model would express $P_{ip}(j)$ as:

$$P_{ip}(j) = g(\Theta_p, \pi_p) \tag{2}$$

where $g$ is a monotone increasing function (also usually the normal ogive or the logistic), and information is collapsed across items (i.e., the absence of parameters running over i).

The proposed person X item theory (P X IRT) model expresses $P_{ip}(j)$ as:

$$P_{ip}(j) = h(\Theta^*, \Phi_i, \pi_p, \delta_{kl}[\Phi_i' \otimes \pi_p]) \tag{3}$$

where $\Theta^* = u(\Theta_i, \Theta_p)$ with some compositional function $u$, $\otimes$ is a right Kronecker product, $\delta_{kl}$ is the Kronecker delta ( = 1 if k = l and 0 otherwise), and $h$ is a monotone increasing function.

*The Importance of Assessing Person Parameters: Current Research*

To evaluate the model, responses from a sample of 971 high school students were obtained for the 16-item Understanding subscale from the Personality Research Form (Form E; Jackson, 1984). Both the item side and the person side parameters were estimated separately. Item parameters are obtained using Muthén's generalized least squares solution for ordered categorical data, whereas person parameters were estimated using the basic construct structure scaling algorithm of Jackson and Helmes (1979). Using a two-step iterative procedure, both components of the model are employed to estimate the interaction aspect of the model.

In addition to the initial development and calibration of the model, other studies are currently underway which investigate the P X IRT model's utility in actual test-taking situations. The goal of these studies is to evaluate the impact of experimental manipulations on the relative weight given to each of the person parameters in the model.

*Implications*

From an instructional perspective, assessing just an item's general performance may not adequately characterize those students whose performance deviates somewhat from central tendency. Thus, it may be of more interest to know in what <u>way</u> a particular individual (e.g., having a certain PCC) responds to a particular item (e.g., having its own ICC), rather than making assumptions about a general PCC form across students. Incorporating person responding with

item responding would provide information about how, for instance, an individual's "threshold" for verbal analogies might be affected by the difficulty of the verbal analogy being responded to.

Educational researchers have recently begun to emphasize the need to account for individual differences in item response models, particularly when attempting to optimize the match between student characteristics and learning (e.g., Messick, 1984; Scheuneman & Steinhaus, 1987). Some work has suggested a host of individual difference variables as potentially influential person characteristics in item responding and appear to map nicely into parameters included in current IRT models (e.g., the lower asymptote parameter: tolerance for error, propensity to guess), some of which are more closely related to the ability measurement than others. The P X IRT model explicitly allows for the possibility that person and item factors are operating in responding.

*Summary: Modelling the Entire Responding Process*

This paper introduces a person by item model of responding by: (1) considering the conceptual usefulness of such a model in understanding item responding; (2) outlining the form of the model; (3) briefly discussing methods for examining the model; and (4) suggesting how educators and test constructors may use this general model to gain more detailed information about individuals' responding to ability measures in light of known item characteristics.

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